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## (54) ELECTRONIC TOLL PAYMENT

SYSTEM ZUM BEZAHLEN VON STRASSEN GebÜHREN  
SYSTEME POUR PAIEMENT DE PEAGE

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EP 0 741 890 B1

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### Description

The invention relates to electronic toll payment and in particular to a system for toll payment by mobiles. A toll is a charge for access to a facility. As far as road vehicles are concerned tolls may be payable for access to roads, tunnels and bridges, for example. As far as individuals are concerned the entrance fees to entertainments such as sporting events or the fares for mass transit facilities may be regarded as tolls.

A problem with toll fee collection is that it takes time and vehicles and individuals are held up by passage through toll gates or turnstiles. Proposals have been made for the electronic payment of tolls whereby fixed sensors interact remotely with devices carried by passing vehicles or persons and, for example, a pre-paid token or card in the device is cancelled or partially cancelled as payment.

US Patent No. 5204675 discloses an automatic toll payment system in which each participating vehicle carries a radio communication device for communicating with a toll station. Data from each communication device identifying the respective vehicle by reference to its licence plate and data providing sufficient information to calculate the toll owed by the vehicle driver are sent to the toll station. The toll station includes a video camera for separately identifying the licence plate of the vehicle and means for comparing the results of these two separate identification methods. The system also includes means for automatically debiting the bank account of the vehicle driver by the amount of the toll or for deducting value from a prepaid sum stored in the communication device. EP-A-0577328 describes a secure toll payment system in which participating vehicles are fitted with a radio communication device within which a smart card may be removably placed. Encrypted signals are passed between the toll station and the communication device with fitted smart card so as to enable the toll to be calculated and the appropriate sum deducted from the prepaid value stored on the card. The toll payment system also includes a video recorder for videoing the licence plate of vehicles which have not successfully paid the toll automatically, and which nonetheless fail to pull over to a manned toll booth when instructed to do so by the toll station.

Facility-specific pre-paid cards (a 'phone card is an example) have the important advantage of anonymity but are inflexible in use. Transactions involving them are insecure and are not themselves fund-transfer transactions. An object of the invention is to facilitate toll payment by electronic cash.

Electronic cash is held in electronic purses. An electronic purse is a device used in a value transfer system for cashless transactions. Value is transferred electronically from one purse to another or from banks' or retailers' terminals. Transfer may be made by direct electronic connection between purses, by telephone connection using modems or by remote communication using infra-

red light or radio. Key features of a satisfactory electronic cash system are true anonymity and security. Security is a particular problem when value messages in the system are broadcast by radio, magnetic or optical/infra-red

- 5 signals as is inevitable in a remote, contactless transaction. A suitable electronic cash system is described in patent application Nos. WO91/16691 and WO93/08545. Here, transactions are truly anonymous and security is ensured by a public/private key encryption system. Individual messages in the system can be transmitted in less than 100ms but there may typically be three or four messages interchanged in a transaction and encryption/decryption of each may take 500ms. Therefore, a typical transaction may take seconds to complete. This is too long to allow swiftly moving traffic to effect a secure electronic cash transaction in passing a toll gantry.

A problem with remote toll payment systems is in maintaining the ability to pursue those who have not

- 20 paid while preserving the principle of anonymity. One method of enforcing payment is to arrange that the electronic purse shall carry a receipt of a completed toll payment. Physical spot checks can reveal non-payment and act as a deterrent. However, it may be preferred to
- 25 enable automatic detection of non-payers. This is particularly difficult if the anonymity of electronic cash is to be preserved.

According to the present invention there is provided a system for toll payment by mobiles comprising, on

- 30 each mobile a mobile communication device and an electronic purse in communication with the device, the electronic purse being part of an electronic cash system, the toll payment system comprising localiser means for localising mobile communication devices, a remote communication system for communicating with mobile communication devices to effect toll payments by exchanging cryptographically secure value transfer messages and means for obtaining a mobile identifier identifying the mobile communication device or the mobile
- 35 carrying the electronic purse, the system being characterised in that means are provided for correlating temporarily the mobile identifier with an identifier for the electronic purse and in that means are provided for (a) discarding the mobile identifier if the toll payment transaction is completed satisfactorily or (b) discarding the
- 40 purse identifier if the toll payment transaction fails.

With this arrangement while anonymity is potentially destroyed by associating the purse identifier with the mobile identifier it is to be noted that this association is temporary only. It is ensured that the association is destroyed by discarding one or another of the identifiers in dependence on the outcome of the transaction. If the transaction is not completed then the mobile identifier can be used to trace the customer. Thus, communication devices may be individually registered to customers and the mobile identifier may be that of the communication device. In particular, the communication device may be a mobile telephone in a cellular telephone system.

The system may be a GSM (Groupe Speciale Mobile) system in which each telephone carries a personal identifier chip. The customer may thus be identified by reference to his registration on the telephone system.

The mobile identifier may take other forms. For example, a photographic or video camera may be positioned on a gantry to photograph the number plates of vehicles in a road toll system. Such photographs or more usually video recordings would be discarded if the toll payment transaction were completed satisfactorily. Alternatively microwave or radio tag identification association with the vehicles or communication devices might be employed.

The localiser means may comprise a physical channelling system to allow individual mobiles to be identified. However, in some arrangements the mere presence of a communication device in a general area or in a particular succession of areas may be sufficient to generate a requirement for a toll payment.

A cellular telephone system gives a coarse location of a telephone by reference to cell identity. This in itself may provide sufficient localiser information in some instances.

Alternatively it is envisaged that localiser information may be obtained from a navigation system such as the GPS (Geographical Position System) satellite system.

The invention will further be described with reference to the accompanying drawings, of which:

Figure 1 is a plan view of part of a toll payment system in accordance with the invention;

Figure 2 is a diagram of the communication device and electronic purse of Figure 1; and

Figure 3 is a schematic diagram of the toll payment system of Figure 1.

Referring to Figure 1 there is shown one three-lane express payment carriageway 1 of a road for which tolls are to be levied. Traffic islands 2 channel the lanes at a toll gantry 3. The three express lanes 4, 5, 6 are for non-stop electronic toll payment. It is to be understood that traffic without electronic payment facilities is diverted through conventional toll gates (not shown).

Each of the three lanes is observed by a respective video camera 7, 8, 9 which is triggered to photograph the rear of each vehicle. Each lane also has a very short range radio transmitter/receiver 10, 11, 12 shielded from its neighbours by electromagnetic shielding to give a respective radio footprint 10f, 11f, 12f covering only its respective lane so as to allow localised communication with a vehicle such as that shown at 13.

Referring now to Figure 2 there is shown a communication device 14 mounted on the dash-board of vehicle 13. The device is connected to a GSM digital telephone 15 in the vehicle and also incorporates a very short range radio transmitter/receiver 16 tuned to the frequency of the units 10, 11, 12 on the gantry. The com-

munication device 14 also has a slot to accept an electronic purse in the form of a smart card 17. This forms part of an electronic cash system of the kind described in patent publications Nos WO91/16691 and WO93/08545. The electronic cash system employs value transactions using encrypted value messages as described in the foregoing specifications.

Referring now to Figure 3 the vehicle 13 is shown having passed the gantry at full speed. On passing the gantry the transmitter/receiver 16 detects a signal from transmitter/receiver 10 and responds with a digital serial signal conveying the identity of the electronic purse 17. This identity is unique in the electronic cash system. The transmitter/receiver 16 passes this identity to a correlator 18 which is linked also to a video recorder 19. The correlator identifies the frames of the video recording pertinent to vehicle 13 and stores this information in a store 19 as a mobile identification signal MID with the associated purse identification information PID.

After sending its PID the communication device is triggered automatically to call a predetermined number on the GSM telephone system and establish a link with an electronic purse 20 of the road operator. An electronic funds transfer is initiated to transfer the toll required from the customer's purse 17 to the purse 20. On satisfactory transfer of the funds an acknowledgement message is sent to purse 17 and this can be displayed on the communication device at 21 (Figure 2).

The PIDs of successful transactions are passed from the purse 20 to a central unit 22 and this is effective to identify the PID in the store and to erase at least the associated MID and preferably both the PID and MID. Thus there is no identifiable correlation between a mobile identifier and a purse identifier for a successful toll payment. The video images may or may not be retained.

Any MIDs which are not cancelled after a predetermined time represent vehicles for which the toll payment has failed for one reason or another. For these MIDs the associated PIDs are deleted to preserve anonymity of the purses. The remaining MIDs are used to identify the appropriate video frames which can be automatically processed to extract vehicle registration numbers in order that their owners can be pursued for payment. Some vehicles may pass along the express lanes with defective or non-existent communication equipment or electronic purses. The video images of these vehicles will be processed for pursuit of toll fees with appreciable surcharge.

The principle of local identification and subsequent payment by electronic cash can be extended to individuals.

Various personal identification methods are available such as personal electronic transponder tags which transmit an identification code on interrogation, or finger-print readers, for example. It is envisaged that an entrance region to a sporting event may be covered by an infra-red communication system allowing the use of hand-held communication devices.

**Claims**

1. A system for toll payment by mobiles (13) comprising, on each mobile (13) a mobile communication device (14) and an electronic purse (17) in communication with the device (14), the electronic purse (17) being part of an electronic cash system, the toll payment system comprising localiser means (2,3,4,5,6,10,11,12) for localising mobile communication devices (14), a remote communication system (10,11,12) for communicating with mobile communication devices (14) to effect toll payments by exchanging cryptographically secure value transfer messages and means (7,8,9,18) for obtaining a mobile identifier identifying the mobile communication device (14) or the mobile (13) carrying the electronic purse (17), the system being characterised in that means (19) are provided for correlating temporarily the mobile identifier with an identifier for the electronic purse and in that means (22) are provided for (a) discarding the mobile identifier if the toll payment transaction is completed satisfactorily or (b) discarding the purse identifier if the toll payment transaction fails.

2. A system as claimed in Claim 1 wherein the remote communication system (10, 11, 12) is a cellular telephone system and each mobile communication device (14) is a mobile telephone and the mobile identifier is the mobile telephone identifier.

3. A system as claimed in Claim 2 wherein the cellular telephone system is a GSM system including personal smart cards and the mobile identifier is the personal identifier in the GSM system.

4. A system as claimed in Claim 1 wherein the mobile identifier is an optical image, the means for obtaining which is a camera (7,8,9) associated with the localiser means.

5. A system as claimed in Claim 1 or 4 wherein the localiser means comprises an observation station associated with a channelling system for the mobiles whereby mobiles (13) may be individually located in channels (4,5,6) as they pass the observation station.

6. A system as claimed in any of Claims 1 to 3 wherein the localiser means identifies the presence of a mobile (13) within a general area.

7. A system as claimed in any of Claims 1 to 4 wherein the localiser means comprises a radio or satellite location system.

**Patentansprüche**

1. System zur Gebührenzahlung durch mobile Einrichtungen (13) umfassend:

eine mobile Kommunikationseinrichtung (14) und einen elektronischen Geldbeutel (17) auf jeder mobilen Einrichtung (13), der mit der Einrichtung (14) in Verbindung steht, wobei der elektronische Geldbeutel (17) ein Teil eines elektronischen Zahlungssystems ist, wobei das Gebührenzahlungssystem eine Lokalisierungseinrichtung (2, 3, 4, 5, 6, 10, 11, 12) umfaßt, zur Lokalisierung von mobilen Kommunikationseinrichtungen (14), ein Fernkommunikationssystem (10, 11, 12) zur Kommunikation mit mobilen Kommunikationseinrichtungen (14) um Gebührenzahlungen mittels Austausch von kryptographisch sicheren Wertübertragungsnachrichten auszuführen, und eine Einrichtung (7, 8, 9, 18) zur Erfassung einer Identifizierung einer mobilen Einrichtung zur Identifizierung der mobilen Kommunikationseinrichtung (14) oder der mobilen Einrichtung (13), die den elektronischen Geldbeutel (17) trägt, wobei das System dadurch gekennzeichnet ist, daß eine Einrichtung (19) zur Verfügung gestellt ist, um die Identifizierung der mobilen Einrichtung mit einer Identifizierung für den elektronischen Geldbeutel in Beziehung zu setzen, und daß eine Einrichtung (22) zur Verfügung gestellt ist, um (a) die Identifizierung der mobilen Einrichtung zu löschen, wenn die Gebührenzahlungstransaktion zufriedenstellend ausgeführt worden ist, oder um (b) die Identifizierung des Geldbeutels zu löschen, wenn die Gebührenzahlungstransaktion fehlgeschlagen ist.

2. System nach Anspruch 1 dadurch gekennzeichnet, daß das Fernkommunikationssystem (10, 11, 12) ein zelluläres Telefonssystem ist und jede mobile Kommunikationseinrichtung (14) ein mobiles Telefon ist und die Identifizierung der mobilen Einrichtung die Identifizierung des mobilen Telefons ist.

3. System nach Anspruch 2 dadurch gekennzeichnet, daß das zelluläre Telefonssystem ein GSM System ist, daß persönliche Smart Cards umfaßt, und daß die Identifizierung der mobilen Einrichtung die persönliche Identifizierung in dem GSM System ist.

4. System nach Anspruch 1 dadurch gekennzeichnet, daß die Identifizierung der mobilen Einrichtung ein optisches Bild ist, wobei die Einrichtung zur Erfassung davon eine Kamera (7, 8, 9) ist, die mit der Lokalisierungseinrichtung in Beziehung steht.

5. System nach Anspruch 1 oder 4 dadurch gekennzeichnet, daß die Lokalisierungseinrichtung eine Überwachungsstation umfaßt, die mit einem Kanalisationssystem für die mobilen Einrichtungen in Beziehung steht, wobei mobile Einrichtungen (13) einzeln in Kanälen (4, 5, 6) angeordnet sein können, wenn sie die Überwachungsstation passieren.

6. System nach einem der Ansprüche 1 bis 3 dadurch gekennzeichnet, daß die Lokalisierungseinrichtung die Anwesenheit einer mobilen Einrichtung (13) innerhalb eines allgemeinen Bereiches identifiziert.

7. System nach einem der Ansprüche 1 bis 4 dadurch gekennzeichnet, daß Lokalisierungseinrichtung ein Funk- oder Satellitenortungssystem umfaßt

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sonnelles et l'identificateur du mobile est l'identificateur personnel dans le système GSM.

4. Système comme revendiqué dans la revendication 1 dans lequel l'identificateur du mobile est une image optique, le moyen pour obtenir celle-ci est une caméra (7,8,9) associée avec les moyens de localisation.

5. Système comme revendiqué dans la revendication 1 ou la revendication 4 dans lequel le moyen de localisation comprend une station d'observation associée à un système de canalisation pour les mobiles dans lequel des mobiles (13) peuvent être localisés de manière individuelle dans des couloirs (4, 5, 6) lorsqu'ils passent la station d'observation.

### **Re vendications**

1. Système pour le paiement de péage par des mobiles (13) comprenant, sur chaque mobile (13) un dispositif de communication mobile (14) et un porte-monnaie électronique (17) en communication avec le dispositif (14), le porte-monnaie électronique (17) faisant partie d'un système de monnaie électronique, le système de paiement de péage comprenant des moyens de localisation (2, 3, 4, 5, 6, 10, 11, 12) pour localiser des dispositifs de communication mobiles (14), un système de communication à distance (10, 11, 12) pour communiquer avec les dispositifs de communication mobiles (14) pour effectuer des paiements de péage en échangeant des messages de transfert de valeur sécurisé de manière cryptographique et des moyens (7, 8, 9, 18) pour obtenir un identificateur du mobile identifiant le dispositif de communication mobile (14) ou le mobile (13) portant le porte-monnaie électronique (17), le système étant caractérisé en ce que des moyens (19) sont fournis pour corrélérer de manière temporaire l'identificateur du mobile avec un identificateur du porte-monnaie électronique et en ce que des moyens (22) sont fournis pour (a) écarter identificateur du mobile si la transaction de paiement de péage est effectuée de manière satisfaisante ou (b) écarter l'identificateur de porte-monnaie si la transaction de péage échoue. 25

2. Système comme revendiqué dans la revendication 1 dans lequel le système de communication à distance (10,11,12) est un système de téléphonie cellulaire et chaque dispositif de communication mobile (14) est un téléphone mobile et l'identificateur du mobile est l'identificateur du téléphone mobile. 30

3. Système comme revendiqué dans la revendication 2 dans lequel le système de téléphonie cellulaire est un système GSM incluant des cartes à puce permettant d'effectuer la procédure d'authentification (15) à l'intérieur d'une zone générale. 35

7. Système comme revendiqué dans l'une quelconque des revendications 1 à 4 dans lequel le moyen de localisation comprend un système de localisation par radio ou satellite. 40

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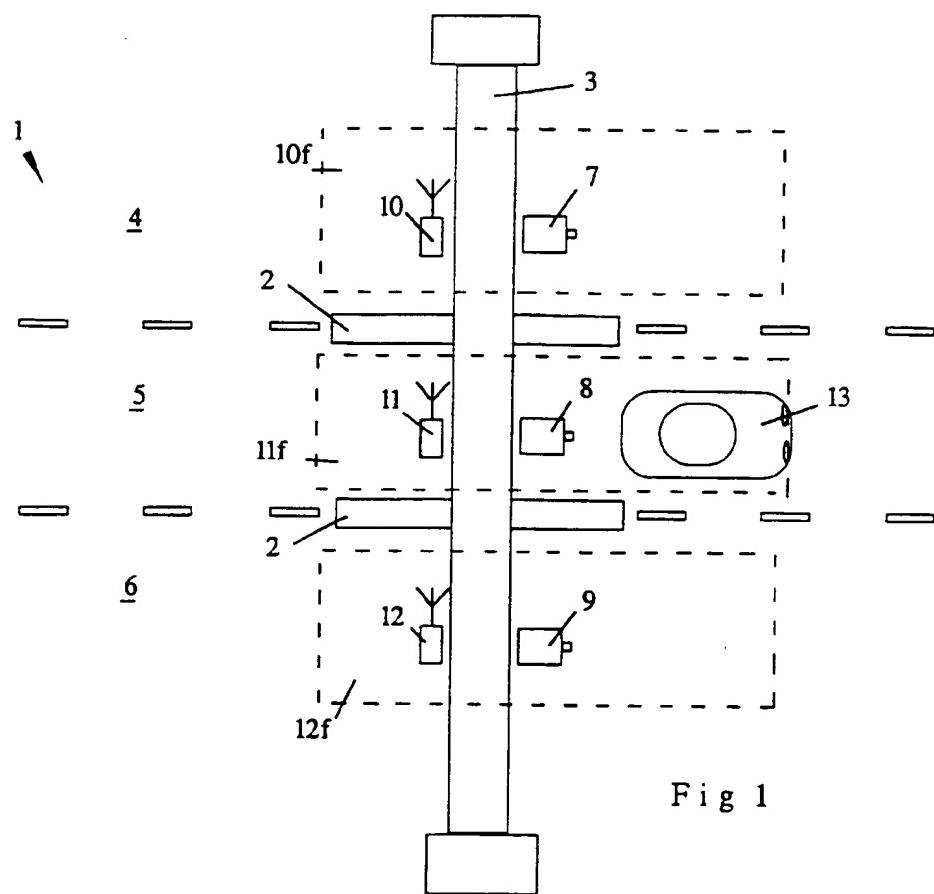


Fig 1

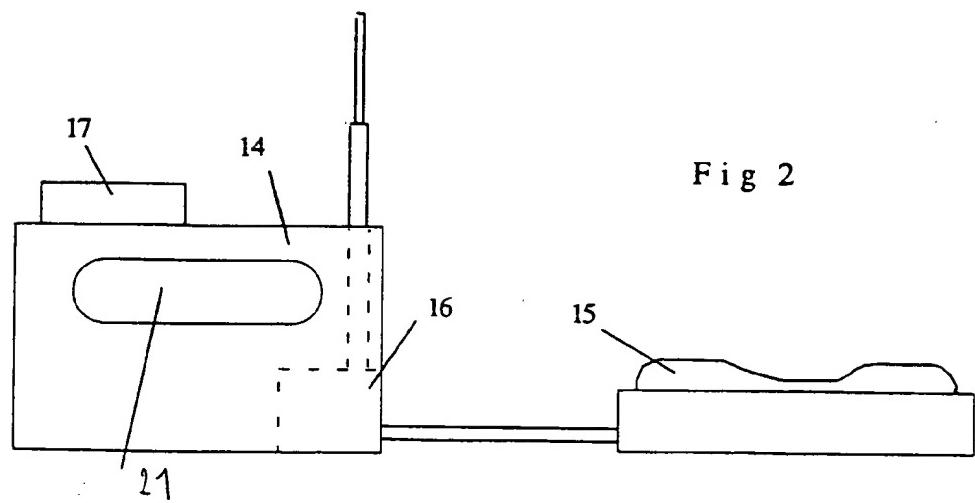


Fig 2

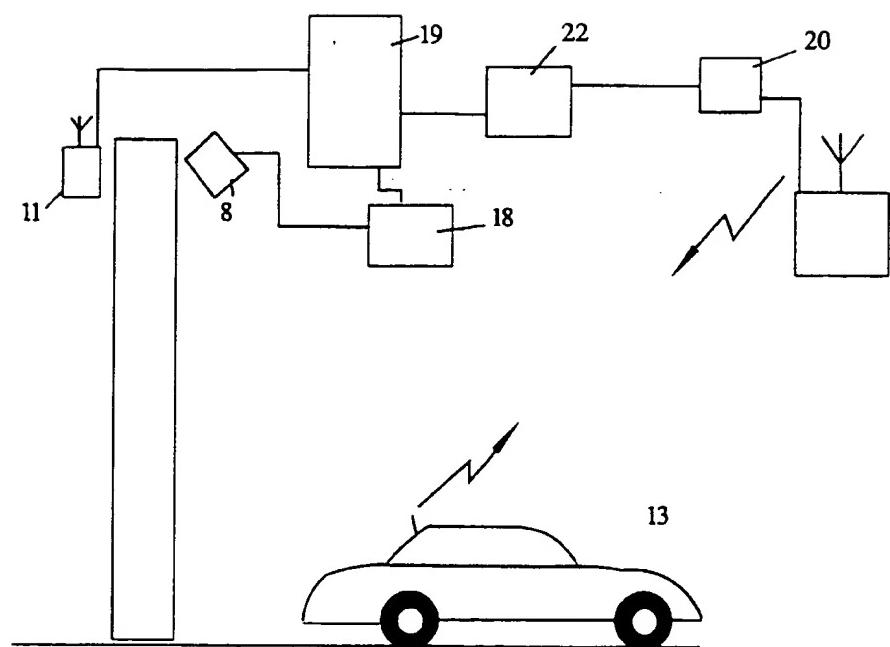


Fig 3